Appendix B
HISTORICAL VEGETATION DISTRIBUTION ALONG THE NORTHWEST FORK OF THE LOXAHATCHEE RIVER

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BACKGROUND

Changes in the balance of fresh and salt water, have resulted in significant changes in freshwater and saltwater vegetation along the floodplain of the river. While cypress and hardwoods can still be found in the protected upper reaches of the Northwest Fork of the Loxahatchee River, the lower undeveloped portions of the river are now dominated by mangrove forest. These anthropogenic alterations within the Loxahatchee River watershed have been well documented throughout the 1900s.

McPherson and Halley (1996), in their publication *The South Florida Environment: A Region Under Stress*, documented the encroachment of mangroves, along with the overall reductions in freshwater flows, maintenance of lower groundwater levels, short duration high volume freshwater flows for flood protection, and changes in the quality of runoff. Earlier, Russell and McPherson (1984) had reported that the freshwater -saltwater interface in the Northwest Fork of the Loxahatchee River moved daily about 0.5 to 1.5 river miles as a result of tides and annually about 3 to 5 miles as a result of seasonal changes in freshwater inflow.

During 1980-81, McPherson (unpublished) studied the transitional area between the cypress forest community and the mangrove community on the Northwest Fork. In May of 1981, he observed surface salinities of 20 to 30 parts per thousand (ppt) in an area of dead and stressed cypress. In another area of intermediately stressed cypress, surface salinities ranged from 15 to 20 ppt. Shallow groundwater salinities decreased with depth below the land surface and distance from the river with the exception of areas where seepage of fresh water was observed from nearby higher pinelands. McPherson found no evidence that cypress forest ever extended much further than his Site 7E (approximately river mile [RM] 5.5) on the Northwest Fork. Site 7E was characterized as an area of dead cypress snags now populated by mangrove forest in the middle of the river. It was assumed that cypress were unable to survive due to high surface and groundwater salinities.

Also, Deuver (unpublished) studied salinities and tree stress in the area of transition between the cypress forest and mangrove communities along the Northwest Fork. In 1980, he noted surface salinities of 5 to 20 ppt in an area of dead and stressed cypress, while surface

salinities in an area of intermediate stressed cypress ranged from 2 to 4 ppt. In an upstream healthy area of cypress forest, surface salinities were less than 2 ppt. In an examination of cypress tree rings taken from core samples, he noted a correlation between ring width, and the quality of ring patterns as indicated by stressful events. They concluded that mangroves were well established in this portion of the river and in downstream portions of Kitching Creek.

Between October 1993 and January 1994, Ward and Roberts (unpublished) examined six vegetative transects on the Northwest Fork of the Loxahatchee River between Indiantown Road (State Road [SR] 706) and the mouth of Kitching Creek (RM 8.0). Generally the density (tree density stems/hectare) of bald cypress (*Taxodium distichum*) increased from downstream (Transect #6, RM 8.5) near Kitching Creek to upstream (Transect #1, upstream of RM 10 just north of SR 706). A noticeable drop in cypress occurred at Transect #3 (upstream of RM 10 and just north of Interstate 95), which was heavily populated with pop ash (*Fraxinus caroliniana*), red maple (*Acer rubrum*), and cabbage palms (*Sabal palmetto*). They did not examine the density of mangroves during their study.

Historical Aerial Photography Studies

Alexander and Crook (1975) utilized aerial photographs and ground truthing to examine plant communities along the Northwest Fork of the Loxahatchee River and Kitching Creek. Plant species lists were compiled for Sites 13 (RMs 7-8), Site 14 (RMs 7.0-7.5), and Site 15 (RMs 6.0-6.5) on the Northwest Fork, and Site 10 on Kitching Creek. Upon identifying the signature of the most abundant community types, they were able to use photointerpretation to identify major vegetative communities from a 1940 aerial photograph. Areas of dead and living cypress canopy with a mangrove understory were noted in 1970. They concluded that since 1940, prairie and swamp hardwoods had lost ground to pineland and mangrove communities due to a lowering of the ground water table and invasion of salt water between RMs 6 and 8. They were able to identify areas of active logging in the aerial photographs, which could explain the loss of mature trees within portions of the watershed. Also, they mentioned the impact of fire, hurricanes, and heavy frost on the major plant communities. At RM 6.5, they collected freshwater peat at a depth of 24 inches below the surface. Based on this information, they further concluded that there was no evidence that cypress forest had extended much further downstream than about RM 6. Wanless (written communication, 1982) suggested that RM 6 has experienced brackish conditions for at least the last 4,500 years. Finally, Alexander and Crook predicted that the mangrove invasion would accelerate if anthropogenic activities in the upper floodplain of the river further reduced the freshwater head.

Hohner (1994) used aerial photography and satellite imagery to examine vegetative changes in the Loxahatchee Slough between 1940 and 1989. The Loxahatchee Slough is part of the headwaters of the Loxahatchee River. In a comparison of the vegetative classes Forest Land (Hammock), Nonforested Wetland (Wet Prairie), Forested Wetland (Cypress), and Nonforested Wetland (Marsh), she concluded that with geographic information system (GIS) analysis there was a general trend toward dryer hydroperiod vegetation land cover. A portion

of the study area, in which water levels were raised to prechannelization levels in 1979, exhibited a recovery to longer hydroperiod vegetation.

This study examines the displacement of cypress and hardwood by mangrove forest along the Northwest Fork of the Loxahatchee River and Kitching Creek using historical black-and-white and color infrared aerial photographs taken over a 55-year period. Color infrared photographs were used for more recent periods. Ground truthing was used to validate the signatures of current major plant communities. Also, this study reexamined local sites ground truthed by Alexander and Crook in 1975 during their investigation of long-term vegetation changes in South Florida. The purpose of this study was to document the changes in vegetative coverage and correlate those changes to major events in the watershed.

Similar historical aerial photographic interpretation studies have been done on the northern Biscayne Bay. Harlem (1979) conducted aerial photographic surveys from 1925 and 1976 aerial photographs of the bay. His work was supplemented with field studies to examine the effects of urban development and natural stresses over time. Maps were created to delineate overall long-term changes in developed land, dredged and spoil areas, decreases in vegetative cover, and increases in bulkheaded shorelines. The major changes observed included the expansion of land areas as a result of filling of swamps, the creation of new islands from dredged spoil material, and changes in circulation patterns as a result of inlet and causeway construction.

METHODS

Aerial photographic interpretation was first developed for use by the military during the First World War. Other uses included mapping of coastal areas and coastlines for maritime purposes. The use of aerial photographic interpretation in investigating environmental changes over time has increased dramatically as aircraft, cameras, and film have improved. The application of aerial photography has advanced along with electronic technology to include multispectral and microwave imaging, and the more sophisticated satellite imaging. Historical aerial photographs provide a tool to map the distribution of subenvironments for any photographed year. By comparing a succession of younger age photographs of the same areas, changes can be monitored and documented for rates of change and long-term trends. It may be possible to identify sources of those changes.

This study of the Northwest Fork of the Loxahatchee River and Kitching Creek utilized black-and-white aerial photographs from 1940 and color infrared Digital Ortho Quads (DOQQs) from 1995. Aerials were obtained from the National Archives in College Park, Maryland, the United States Department of Agriculture, the Consolidated Farms Service Agency Aerial Photograph in Salt Lake City, Utah, and the National Aerial Photography Program. The 1940 aerial photographs (Accession Numbers CJF 3-51,17-53, 17-54) were taken on August 21, 1940, at a scale of 1:40,000, while the 1995 aerial photographs (Accession Number NAPP 6966-089) were taken on January 26, 1995, at a scale of 1:40,000. The 1940 photographs were scanned at a scale of 3 inches per pixel and

georeferenced to the 1995 DOQQ's. The 1995 aerials for the DOQQ's were scanned at a 1-meter pixel resolution and rectified to meet a 1:12000 scale accuracy for the quarter quadrangles. All imagery was produced in the State Plane Coordinate System, Florida East Zone, 1983 Datum. Total vegetative community coverage by type and by year was compared over time to quantify changes in vegetative types.

To validate the images produced by the major plant community types in the floodplains and associated upland communities, ground truthing and field observations were conducted from a helicopter on October 19 and November 1, 2000, and from ground surveys on November 14, November 29, and December 12, 2000. Dominant species of plants in the canopy and understory were noted on hard copies of the photographs.

Several plant community types used by Alexander and Crook (1975), i.e. pineland (P), swamp hardwood (SH), and mangrove (M), were adopted for use on this study for black-and-white historical aerial photographs. For color and infrared photographs, plant community signatures utilized in this study were adopted from the Florida Land Use Cover and Forms Classification System (FLUCCS) (FDOT 1985). Color and texture descriptions listed in the reference document were compared with known vegetation from the 1995 aerial to establish the following list of observed classifications:

<u>Color Infrared</u>
243 Ornamental Garden
400 Upland Forests
    428 Cabbage Palm
500 Water
    510 Streams and Waterways
600 Wetlands
    612 Mangrove Swamp
    615 Stream and Lake Swamp
    616 Inland Pond and Slough
    621 Cypress
    641 Freshwater Marshes
700 Barren Land
    740 Cleared Lands

<u>Black-and-White</u>
Pineland (P)
Swamp Hardwood (SH)
Mangrove (M)
Streams and Waterways (W)

Using these categories, major plant communities were delineated into distinct aerial units characterized by specific tones and textures. Image tones refers to the brightness of an area of background as portrayed by the film in a given spectral region (or in three spectral regions for color or color infrared). Image texture refers to the apparent roughness or smoothness of an image region. Texture is produced by the pattern of highlighted and shadowed areas as an irregular surface is illuminated from an oblique angle. Mature forest appears as rough texture, while agricultural fields appear as smooth texture. Categories such as cypress may be recognized by the distinctive shape of the pin-like crowns of some trees (Campbell, 1987). **Table B-1** (at the end of the appendix) provides a list of the major plant communities and their signatures for color infrared photographs.

RESULTS

Comparison of 1940 and 1995 Vegetation Coverages along the Northwest Fork of the Loxahatchee River

Geographically, the Loxahatchee River watershed can be characterized as subtropical with average daily temperatures of 82 degrees Fahrenheit (° F) in summer to an average winter temperature of approximately 66° F. The region receives approximately 60 inches of rain annually. The landscape is topographically divided into two landforms: the Atlantic Coastal Ridge and Eastern Flatlands. Vegetative communities consist primarily of coastal hammock, pine flatwood, seasonal ponds and prairies, freshwater swamp hardwood, and mangrove.

Much of the region remains unurbanized today due to earlier military and agricultural uses. Subsequently, land use changed to large tracts of public conservation and recreation and agricultural lands and 5- to 10-acre ranches. The Northwest Fork has been provided with additional protection as portions of this water body have been designated as a federal wild and scenic river. The oldest municipality is the Town of Jupiter, which was incorporated in 1925. Neighboring municipalities, Juno Beach, Jupiter Inlet Colony, Jupiter Island, Palm Beach Gardens, and Tequesta, were all incorporated during the 1950s (**Table B-2** at the end of the document). Today the primary land uses are public conservation and recreation, agriculture, and residential development.

1940 Vegetative Communities

The Loxahatchee River watershed was largely undeveloped in 1940. According to the 1940 United States Census, the Town of Jupiter contained 215 residents (**Table B-2**). Interstate 95 and the Florida Turnpike had not yet been constructed. The major roads in the area were Center Street, SR 706 (Indiantown Road), SR 710 (Beeline Highway), United States Federal Highway 1 (US 1), Bridge Road, and Northlake Boulevard. Also, the C-18 canal had not yet been constructed, although evidence has been found of ditching southward to the Loxahatchee and Hungryland Sloughs. The Jupiter Inlet was open in the 1940 photograph, but the presence of sandbars probably reduced the amount of salt water coming in during high tides. The inlet was not permanently stabilized for navigation until 1947. On the Northwest Fork, incoming tides reached upstream past the mouth of Kitching Creek frequently enough to produce a fringe of mangroves along the river ending at RM 8.5 on the northern bank.

The most obvious features of the 1940 aerial photographs are the abundance of wetlands associated with sloughs and wet prairies and the lack of urban development throughout most of the watershed. The three main tributaries of the river and the surrounding lands resemble a cross-section through a kidney with the river acting as the main outgoing duct, while the uplands and sloughs resemble a network of interconnecting sinuses. There are extensive wetlands (prairies and four major sloughs) between Kitching Creek, the North Fork

of the river and Bridge Road in Martin County. Two of the sloughs appear to connect the North and Northwest Forks. All four sloughs would have provided a source of fresh water that is not present today. Of the four sloughs, only Wilson Creek remains connected to the river today.

Other visible hydrologic characteristics in the 1940 photographs included the following:

- On the Northwest Fork, Hobe Grove Ditch did not exist but Moonshine Creek was apparent and drained a wetland slough to the north.
- No citrus was grown near the river as it is today, but there was extensive land clearing north of SR 706 on the east side of the Northwest Fork, perhaps for agriculture.
- A wetland slough connected Jones Creek to Lake Worth Creek in the vicinity of what is today Frenchmen's Creek.
- Jones and Sims Creeks were lined with mangroves south of SR 706.
- The Southwest Fork was a small meandering creek dominated by mangroves.
- The Southwest Fork/Limestone Creek had been ditched but not channelized.
- Mangroves bordered the North Fork and transitioned into freshwater vegetation in the vicinity of today's park boundary (north of the Girl Scout Camp). The floodplain was very narrow in the mangrove areas.
- There were very few mangrove islands in the embayment area.
- Spoil mounds were evident along the Lake Worth Creek and the lower Indian River Lagoon from the dredging of the Atlantic Intracoastal Waterway channel.

Figure B-1 illustrates the 1940 distribution of freshwater and brackish water vegetation in the floodplain of the Northwest Fork. Mangroves (predominately red mangroves, *Rhizophora mangle*) dominated the river between RMs 4.5 and 6.0. A concentration of mangroves appears to be associated with the southward bending of the river between RMs 7.5 and 8.5. This could be associated with past lumbering activities in which the land had been cleared of freshwater vegetation and returned as mangrove or just a factor of propagule distribution. No mangroves appeared to be present within Kitching Creek. Freshwater swamp hardwoods were present from about RM 6.0 and were dominant upstream above RM 7.0 and within the major tributaries of the Northwest Fork.

Figure B-1. 1940 Loxahatchee River Watershed.

Table B-3 (at the end of the document) provides a breakdown of the total observed 1940 coverages. An estimate of the location of Interstate 95 and the Florida Turnpike were made to define the southern boundary of the study area. With the exception of concentrated areas of cabbage palms, the clarity of the black-and-white photography was not distinct enough to identify species within the freshwater canopy. Because the dominance of cypress could not be validated, the category of "Swamp Hardwood" from Alexander and Crook's (1975) study was used for freshwater communities. In 1940, the floodplain had 172 acres of mangroves and 460 acres of swamp hardwoods. The area of ornamental vegetation includes an exotic ornamental plant garden established by Mrs. Alice De Lamar.

1995 Vegetative Communities

Beyond the obvious publicly-owned lands and agricultural fields, the eastern portions of the Loxahatchee River watershed were highly urbanized in the 1995 photographs. During a 1999 estimate by the United States Census Bureau, the Town of Jupiter reported a population of 33,925 residents within the city limits. Jupiter residents plus neighboring municipalities accounted for a population of 77,484 residents (**Table B-2)**; however, this figure does not include the residents of unincorporated Palm Beach County in the western portion of the watershed. Major features include and the 11,471 acres of Jonathan Dickinson State Park, Interstate 95 and the Florida Turnpike, which bisect the landscape, and extensive areas of agriculture (primarily citrus and cattle grazing).

Some of the most obvious features along the Northwest Fork were the dredged and filled areas that were formerly mangrove islands between RMs 4.5 and 5.5 and the loss of floodplain due to hardening of both shorelines (i.e. bulkheads) along the lower Northwest Fork and in the upper Northwest Fork, where upland species (i.e. saw palmetto, slash pine, etc.) have invaded the floodplain. Also, the islands and oxbows of the Northwest Fork appeared to have been heavily scoured over the last 55 years. This is apparent in total acreage differences between the 1940 and the 1995 coverages (**Table B-3**). There is a loss of approximately 127 acres of vegetation in the floodplain area over this 55-year period.

Figure B-2 illustrates the 1995 distribution of vegetation within the floodplain. Color infrared photography allowed for the identification of a greater number of plant categories and better observation of vegetative changes. In 1940, mangroves were dominant between RMs 4.5 and 6.5 and were present up to RM 8.5. Fifty-five years later, mangroves had progressed upstream as the dominant vegetation in the floodplain between RMs 5.5 and 8.6. Between RMs 8.6 and 10, they share the floodplain area with cypress and other freshwater hardwoods. Also, there are mangroves present now within the lower portion of Kitching Creek. Near the mouth of the creek, the mangroves appear as forests ,whereas further upstream they appear as understory to a cypress canopy. In 1995, there were approximately 155 acres of mangroves and 311 acres of freshwater vegetation (**Table B-3**) along the Northwest Fork (east of Interstate 95 and the Florida Turnpike). In this case, freshwater vegetation consisted of stream swamp (188a.), cypress (115a.), and freshwater marsh (8a.).

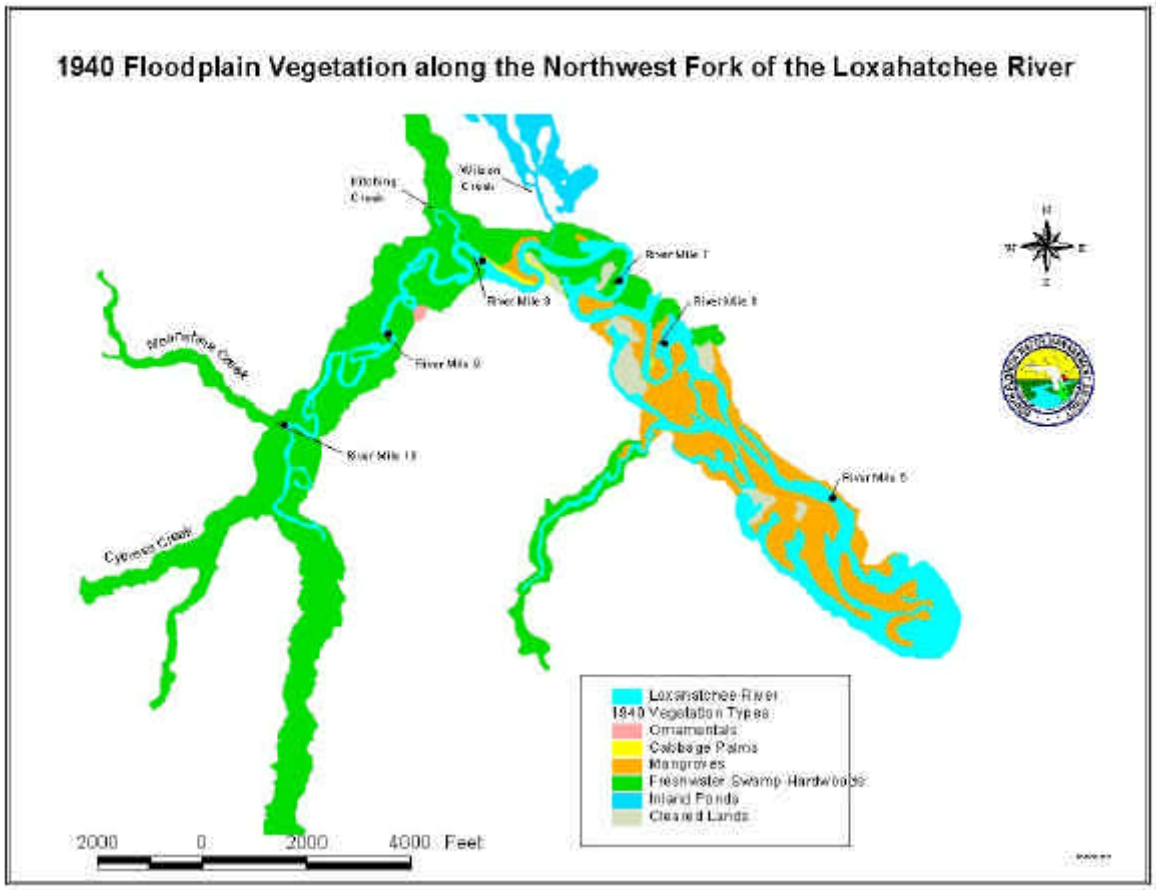


Figure B-2. 1940 Floodplain Vegetation along the Northwest Fork of the Loxahatchee River.

Between 1940 and 1995, mangroves exhibited losses and gains in total coverage (**Figure B-3**). Approximately 84 acres of mangroves were lost due to development of formerly mangrove islands between RMs 4.5 and 5.5. Mangroves gained another 149 acres from reestablishing in cleared lands (6%) and from invading freshwater communities (32%). The gains in coverage occurred primarily between RMs 6.0 and 8.5. Approximately 165 acres of mangroves remained unchanged over the 55-year period.

During the study period, no overall gains in freshwater vegetation occurred. Infrared photography allowed for the identification of freshwater marsh associated with the wider floodplain areas. Losses of freshwater hardwoods have occurred due to the invasion of mangroves, scouring of the river, lumbering activities, and changes in the hydroperiod. It was also noted in the field that many of the remaining freshwater marsh areas have been invaded by the exotic old world climbing fern, *Lygodium microphyllum*. Also, it has been suggested that mangroves had taken over areas that were formerly freshwater marsh. Overall, 149 acres of freshwater habitat were lost (i.e. mangroves gained), primarily between RMs 6.5 and 8.8 (**Figure B-3**). Within the remaining freshwater communities along the open river (RMs 9.0 to 10.5), no changes in the signature of the canopy were observed. Whereas the 1940 black-and-white photographs had exhibited a very uniform canopy among swamp hardwood areas, the

1995 photographs exhibited a canopy of more varying heights, colors, and textures. Field observations and geographical coverages showed that while there were remaining areas of greater than 50% cypress, other areas consisted of a mixture of water tolerant hardwoods including red maple (*Acer rubrum)*, water hickory (*Carya aquatica)*, laurel oak (*Quercus laurifolia)*, pond apple (*Annona glabra)*, popash (*Fraxinus caroliniana)*, dahoon holly (*Ilex cassine)*, and swamp bay (*Persea palustris)*. These areas were designated as "Stream Swamp" in the 1995 coverage. Changes within the freshwater communities (i.e. increases in diversity and a loss of cypress as the dominant species) suggest that the hydroperiod has changed to less frequent inundation of the floodplain. This is reflected by the 1995 distribution of mangroves and freshwater coverages in the Hobe Grove Ditch and Cypress Creek areas (**Figures B-3 and B-4**). Areas dominated by cypress appear to be more closely associated with wider floodplains suggesting that there may be less species competition and less water stress associated with these areas.

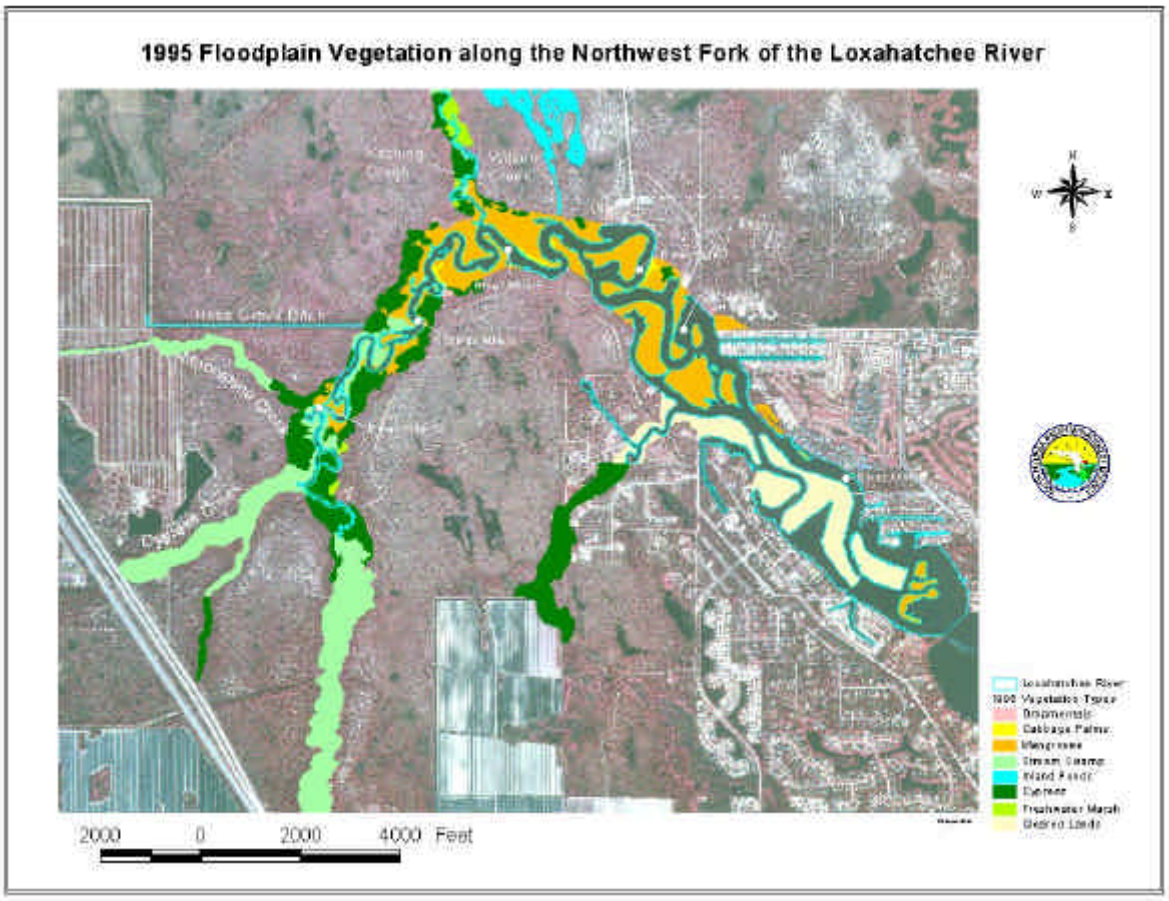
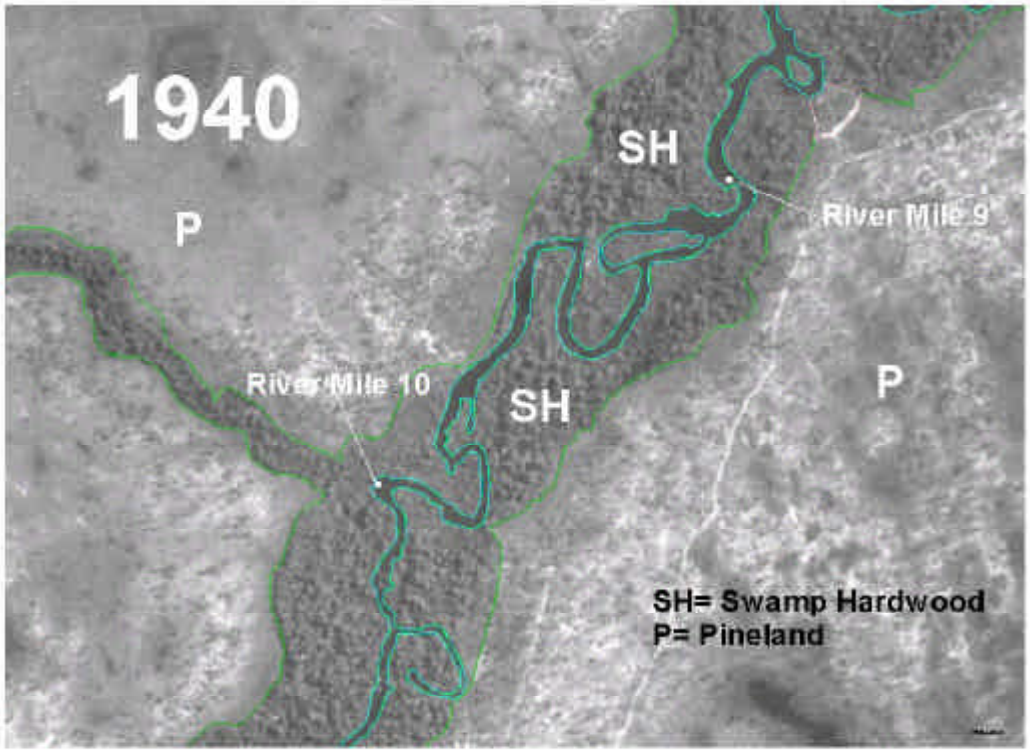


Figure B-3. 1995 Floodplain Vegetation along the Northwest Fork of the Loxahatchee River.


1940
SH
P
River Mile 9
River Mile 10
SH
P
SH= Swamp Hardwood
P= Pineland

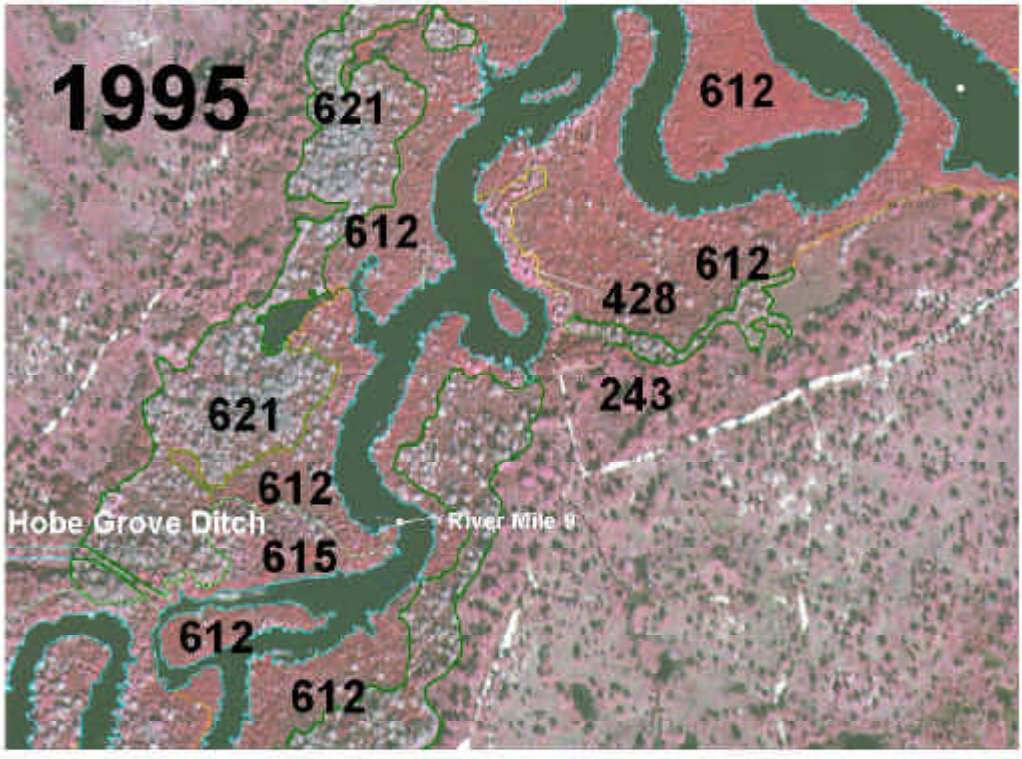

1995
621
612
612
612
428
621
243
612
Hobe Grove Ditch
River Mile 9
615
612
612

Figure B-4

Other visible hydrologic characteristics in the 1995 photographs included the following:

- The Southwest Fork was channelized between 1957 and 1958 to create the C-18 canal, leaving very few remaining mangroves.
- The C-14 canal and the G-92 structure were constructed in 1974 to redirect water from the Northwest Fork to the Southwest Fork.
- Over 3,000 acres of citrus groves have been planted west of the Northwest Fork .
- Hobe Grove Ditch was dug through uplands to provide flood control for the citrus groves during the 1960s and now surface water is being retained to rehydrate the farm's irrigation wells.
- Most of the remaining inland ponds and sloughs appear to be much smaller in size than in the 1940 photographs.

Comparison with 1970s River Vegetation Studies

The 1973 field observations of Alexander and Crook (1975) provided us with the unique opportunity of having a historical record of the existing floodplain vegetation in several locations along the Northwest Fork and Kitching Creek. Site 10 was located on Kitching Creek, while Sites 13, 14, and 15 were located on the Northwest Fork (**Figure B-5**).

A comparison of this studies and Alexander and Crook's (1975) interpretations of 1940 vegetation from historical aerials revealed different results. Alexander and Crook (1975) interpreted Site 10 as a swamp hardwood dominated by water oak, red maple, popash, and pond apple. They interpreted Sites 13 and 14 as mangrove river communities with a canopy of dead cypress and cabbage palms and Site 15 as a live cypress canopy with a mangrove understory. In our interpretation of these same areas, Sites 10, 14, and 15 were still swamp hardwoods, while Site 13 was partially mangrove and swamp hardwood (**Figure B-5**).

In their interpretation of 1970 black-and-white aerials and their 1973 field observations, Alexander and Crooks (1975) observed that Sites 14, 15, and most of Site 13 were mangrove river communities. Within Site 10, swamp hardwoods occurred just outside of the mouth of Kitching Creek.

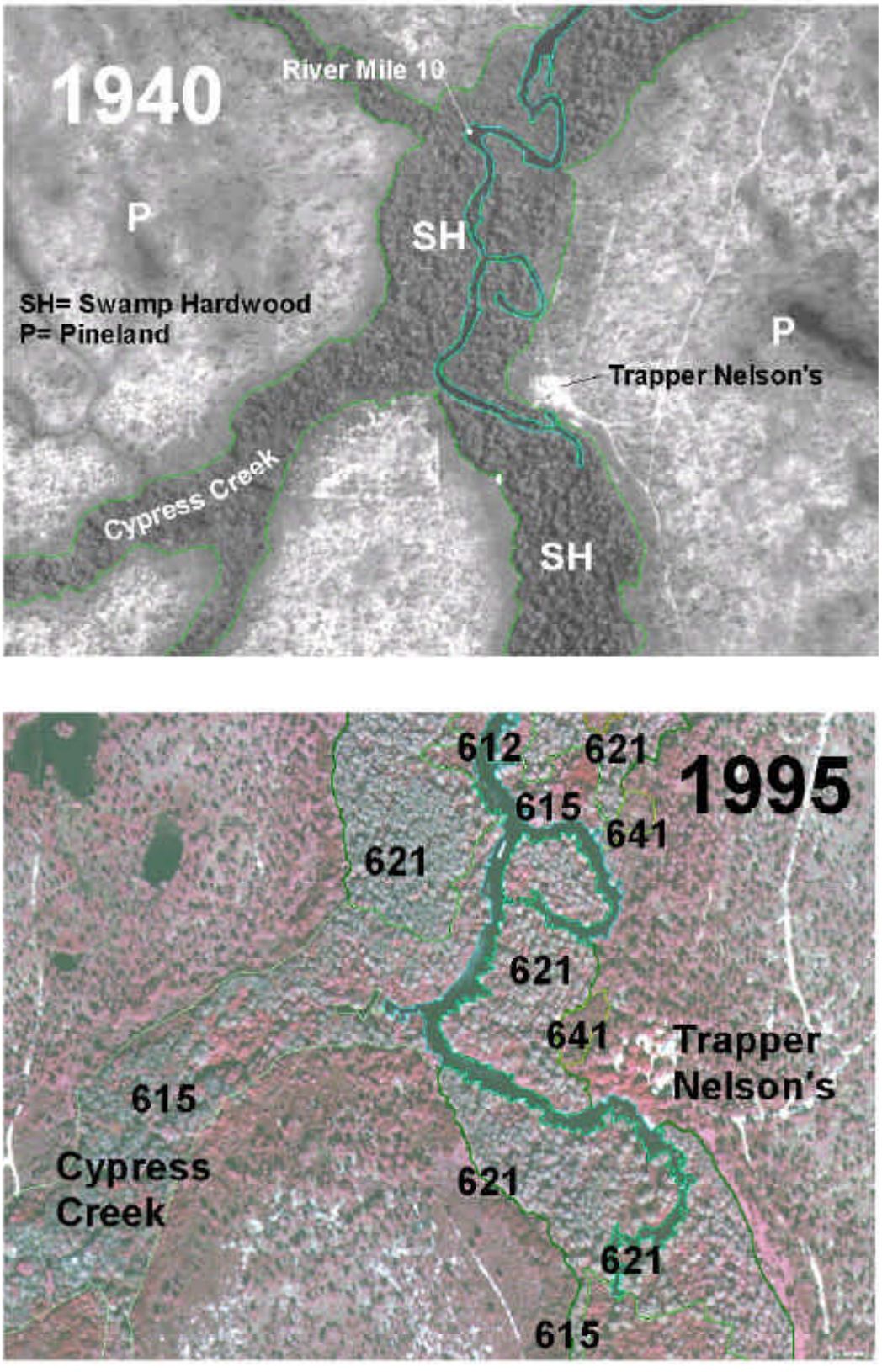

1940
River Mile 10
P
SH
SH= Swamp Hardwood
P= Pineland
P
Trapper Nelson's
Cypress Creek
SH
612
621
615
641
1995
621
621
641
Trapper
Nelson's
615
Cypress
Creek
621
621
615

Figure B-5.

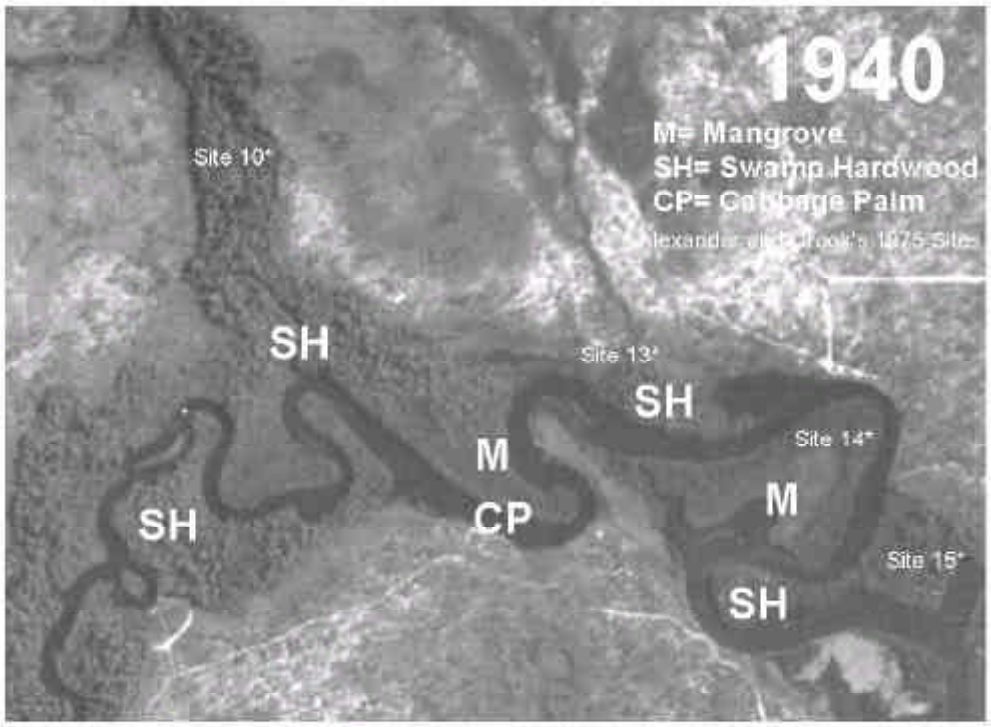
Field surveys conducted by South Florida Water Management District (District) staff of these same sites in November 2000 are shown in **Figure 6** and include the following notations:

- Site 10 (Kitching Creek) - Mangroves are present up to the second bend in the creek and occur further upstream as understory. Freshwater communities were a mixture of cypress, stream swamp, and freshwater marsh. The largest freshwater marsh area is dominated by pond apples.
- Site 13 - This site is almost completely mangrove. A small remnant of the live cypress remains on the northern boundary adjacent to the uplands probably due to its distance from the riverbed and influence of the adjacent ground water.
- Site 14 – This site is a large red mangrove island with leather fern and *Crinum americanum* (string lily) in the understory. It has not changed except the tree heights no longer reach 30 feet due to impacts from past freezes.
- Site 15 – This site is predominately mangrove with live cypress remaining along a northeastern ridge and some concentrated areas of cabbage palms found on another ridge area.

DISCUSSION OF IMPACTS OF HYDROLOGICAL ALTERATIONS AND METEROLOGICAL EVENTS ON RIVER VEGETATION COMMUNITIES

Odum et al. (1982) noted that one generally unrecognized side effect of lowered freshwater flow and saltwater intrusion has been the inland expansion of mangrove forest. The examples that were given included the mangrove borders of Biscayne Bay and much of the Everglades. These forests have expanded inland since the 1940s in conjunction with man's alteration of surface and groundwater flows.

Red mangroves are particularly very successful invaders. Their rod-shaped propagule promotes very efficient tidal transport, and they have the lowest seedling mortality rate compared to other mangrove species (Rabinowitz, 1978a). Davis (1940) noted that floating red mangrove propagules remain viable up to 12 months. In addition, Rabinowitz (1978b) observed that red mangrove seedlings can become established under an existing, dense canopy and then due to their superior embryonic reserves, are able to wait for months for tree fall to open up the canopy and present an opportunity for growth.


1940
M= Mangrove
SH= Swamp Hardwood
CP= Cabbage Palm
Site 10*
Site 13*
Site 14*
Site 15*
SH
SH
M
CP
SH
M
SH

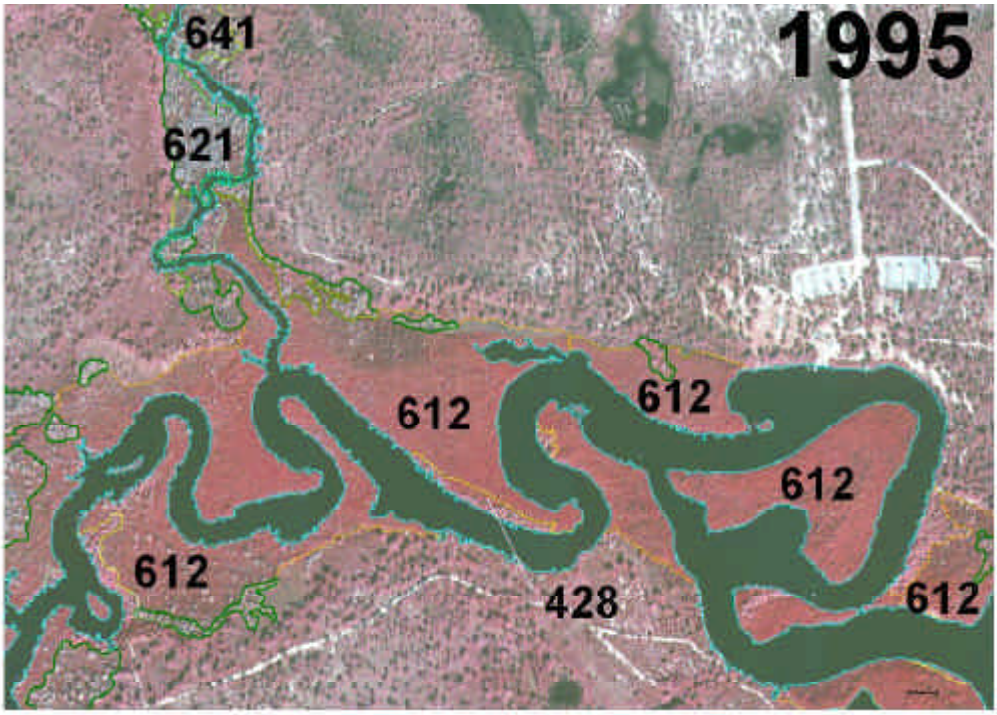

1995
641
621
612
612
612
612
428
612

Figure B-6.

The opening and closing of Jupiter Inlet, and the reduced inflows of surface water, and the subsequent drop in the groundwater table has promoted the distribution of mangroves and taken its toll on the freshwater habitat of the Northwest Fork of the Loxahatchee River. The altered saltwater wedge has produced major changes in the freshwater vegetative communities. In many areas, mangroves now dominate habitat that was formerly dominated by freshwater cypress and has produced additional changes within remaining freshwater communities with the expansion of species that favor dryer hydroperiods and are more salt tolerant. Urban development within the headwaters and the major tributaries will continue to reduce freshwater inflow and make any efforts towards preserving this historical flora more difficult.

Hurricanes have effected the watershed by producing rises in tidal levels, opening and closing of inlets, changes in topographical and land contour and by producing severe physical damage to vegetation. Major hurricanes and tropical storms occurred in the vicinity of the Loxahatchee in 1928, 1933, and 1981. Hurricanes have also been known to spread plant propagules over long distances with their waves and high tides.

Severe droughts were recorded in 1937-38, 1943-44, 1950-51, 1955-56, 1960-61, 1966-67, and 1970-71. Droughts effect vegetation through "water stress" and saltwater intrusion. Richardson (1977) stated that only isolated stands of cypress exist in places that at one time were extensive forests. Virtually no seed germination is taking place in coastal strands because of the lowered water level. Cypress need a hydroperiod for a number of months before germination may take place. Also, Pezeshki et al. (1987) observed that flooding one-year-old bald cypress seedlings above 2 ppt reduced CO_2 fixation by 40-65% and net photosynthesis by 51-70%. All saline treatments resulted in leaf injury with greater damages at higher salinities. Their study suggested that saline water produces an excess accumulation of sodium and chloride, which may affect different plant processes in cypress.

Historical heavy frost winters were reported in 1939-40, 1957-58, 1962-63, and 1964-65 (Alexander and Crook, 1975) and in 1977, 1983, 1985, and FDEP, 2000). Evidence of a major meterological event was apparent from infrared aerial photographs taken in April 1985. These photographs, which were flown as a special flight for the District were briefly examined but not digitized. Mangroves along the Northwest Fork were defoliated and trees of 30 foot or more exhibited broken branches and trunks. Air temperatures during January and February 1985 had fallen to 25º and 30º F, respectively (United States Department of Commerce, Climatological Data: Florida). Mangroves do not tolerate temperature fluctuations exceeding 18° F or temperature below freezing for any length of time (Odum et al., 1982). They may defoliate after exposure to 45° F. or less. This may explain why mangroves along the Northwest Fork of the Loxahatchee River are not reaching the height of mature mangroves, which can range between 60 and 80 feet.

Although mangroves have taken over a considerable amount of the downstream historical coverage of freshwater vegetation along the Northwest Fork of the Loxahatchee River, the Wild and Scenic River segments of the waterway continue to be a valuable natural resource and tourist attraction with both mangrove and cypress habitats. As in coastal areas,

mangroves still provide shoreline stabilization, wildlife habitat, and aesthetic values. Restoration efforts must include measures to restore the historic salinity regime in the Northwest Fork to prevent further loss of freshwater habitat. In addition, measures must be taken to reduce the impact of predicted rises in sea level as a result of global warming.

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Table B-1. Major Plant Communities and their Signatures for Color Infrared Photographs

Major Plant Communities	Signature	Vegetation	Hydrology/Soils
300 Rangeland 321 Palmetto Prairies	Bright pink, stippled appearance	Saw palmetto is the dominant species. Other potential species: bluestems, panic grasses, fetterbush, gallberry, and wax myrtle	Good drainage, seldom inundated
400 Upland Forest 428 Cabbage Palm	Dull, medium red color return with a predominantly fluffy and irregular crown texture with individual crowns discernable	cabbage palms with live oaks and vines	Rarely inundated/ fine sands well to somewhat poorly drained
500 Water 510 Streams and Waterways	black color for rivers streams, creeks, canals and other water bodies		
600 Wetlands 612 Mangrove Swamp	Smooth "cottony" red with generally even height* Areas of stress may appear as bright greenish color with a rough or stipple texture	Dominated by red, white or black mangroves (red towards the water's edge, blacks toward the landward side, whites more landward Other species Buttonwood, seagrape, palms, brazilian pepper, cocoplum	Permanently to tidally flooded/ very poorly drained organics or saline sands
615 Stream & Lake Swamps	Varying size canopies of irregularly shaped crowns from very pin-like (cypress) to mid-size fluffy and cottony overlapping crowns of broad leaf deciduous hardwoods. Cypress greyish green other hardwoods red color returns	Dominated by a mixture of water tolerant hardwoods including red maple, water oak, sweetgum, willows, water hickory, bays Cypress present but not dominant	Seasonal inundation depending upon weather cycles/ Soils mixture of sand, organics, and alluvial materials
616 Inland Ponds & Sloughs	Similar return as 615; however, these areas are found in depressions (ponds) and poorly drained defined drainages (sloughs) not associated with rivers or creeks	Dominated by cypress, red maples, willows with no single species dominating	Semi-permanent or permanent hydroperiods with a few inches of slowly moving water/ Soils highly organic sands or layered
621 Cypress	gray or gray-green color, narrow, densely packed crowns Tallest trees near the center with younger smaller trees along the edges	Dominated by cypress bald or pond Other species: red maple, pond apple, pop ash, water hickory In drier sites laurel oaks, sweet gum and bays	Semi-permanent or permanent hydroperiods/Poorly or very poorly drained, high in organics with peat layer of varying thickness on the surface
641 Freshwater Marshes	Variable, black open water, areas of faint pink to white return (floating aquatic vegetation), other vegetation pink to red range producing a smooth to stippled texture Sawgrass and cattail greenish to greenish-white return	Dominated by herbaceous vegetation including maidencane, common reed, cordgrass, bullrush, sawgrass and cattails with some pickerelweed and arrowhead	Seasonally to permanently flooded, may dry out during droughts/ Very poorly drained, mineral or organic

*We noted that darker tones of red within the mangrove community appeared to be taller/older trees that had not been as impacted by past freezes. These areas could be found generally in the interior of the communities and had perhaps been shielded from the colder temperatures and stronger winds.

Table B-2. Population as Reported in the U.S. Census in the Loxahatchee River Watershed

Municipality	Year						
	1940	1950	1960	1970	1980	1990	1999*
Juno Beach	-	-	249	747	1,142	2,172	2,903
Jupiter	215	313	1,058	3,136	9,868	24,907	33,925
Jupiter Inlet Colony	-	-	242	396	378	405	416
Jupiter Island	-	-	114	295	364	549	561
Palm Beach Gardens	-	-	-	6,102	14,407	22,990	34,557
Tequesta	-	-	199	2,642	3,685	4,499	5,122
Total	**215**	**313**	**1,862**	**13,318**	**29,844**	**55,522**	**77,484**

*Estimated by Bureau of Economic and Business Research, University of Florida

Incorporation Dates:
Juno Beach 1953
Jupiter 1925
Jupiter Inlet Colony 1959
Jupiter Island 1953
Palm Beach Gardens 1959
Tequesta 1957

Table B-3. Vegetative Coverages for 1940 and 1995

1940 Vegetation	Count*	Acres	1995 Vegetation	Count*	Acres
Ornamental	1	1.44	Ornamental	1	0.64
Cabbage Palm	2	3.08	Cabbage Palm	5	4.30
Mangrove	24	163.06	Mangrove	35	154.74
			Stream Swamp	14	188.37
Inland Ponds and Sloughs	1	58.55	Inland Ponds and Sloughs	1	38.63
Swamp Hardwood (Cypress)	12	467.21	Cypress	22	128.06
			Freshwater Marsh	6	8.09
Disturbed or Cleared Lands	7	26.82	Disturbed or Cleared Lands	6	83.61
Total		**729.55**	**TOTAL**		**608.55**

* Number of polygons